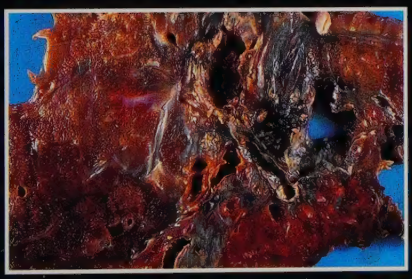
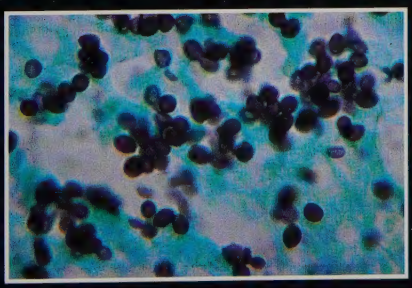
# Color Atlas of Respiratory Disease





Volume 3 of 4

# Color Atlas of Respiratory Disease

*Volume 3 of 4*

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# Introduction

Respiratory disorders represent a diverse group of diseases that pose a diagnostic challenge for the clinician. *The Color Atlas of Respiratory Disease,* a four-volume atlas, includes images of direct or indirect visualization of the respiratory tract. Radiographs, computed tomography and magnetic resonance imaging, and bronchoscopy views, as well as cytology and biopsy slides and ECG tracings, are presented to assist the clinician in making a diagnosis.

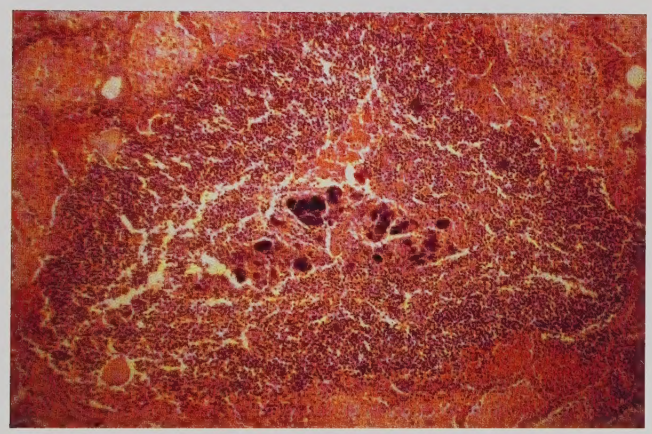
A wide variety of pulmonary disorders are included within the four volumes: Volume 1, diseases of the upper respiratory tract and pulmonary vascular disease; Volume 2, airway diseases; Volume 3, respiratory tract infections; and Volume 4, parenchymal and pleural disorders. Different presentations of the disorder and/or its progression are shown. The captions describe the image and its interpretation rather than the disease and its etiology and management.

Volume 3 focuses on bacterial, fungal, and viral infections that affect the respiratory tract. It is hoped that this atlas will prove valuable to you in your practice of clinical medicine.

Respiratory
Tract
Infections

1

**1 ♦** Autopsy specimen showing multiple pulmonary abscesses/areas of infarction associated with *Staphylococcus aureus* pneumonia/sepsis.



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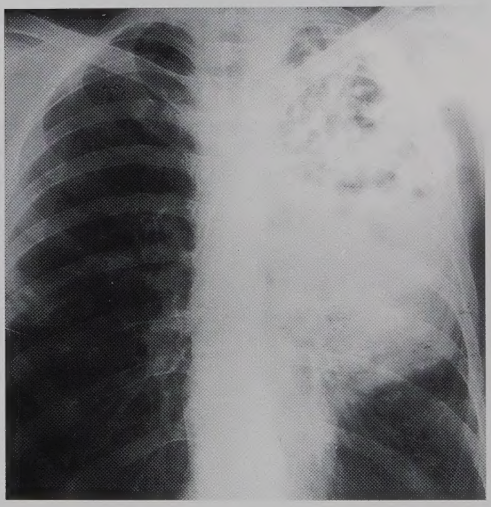
**2 ♦** Lung tissue with *Staphylococcus aureus* pneumonia. Hematoxylin-eosin stain depicts a microabscess within the pulmonary parenchyma. The inflammatory cell infiltrate is quite prominent. Spontaneous drainage of necrotic material can lead to cavitation.



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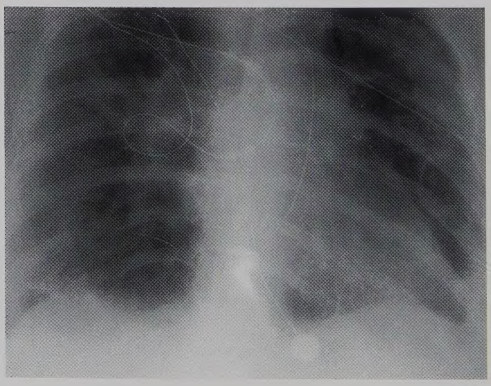

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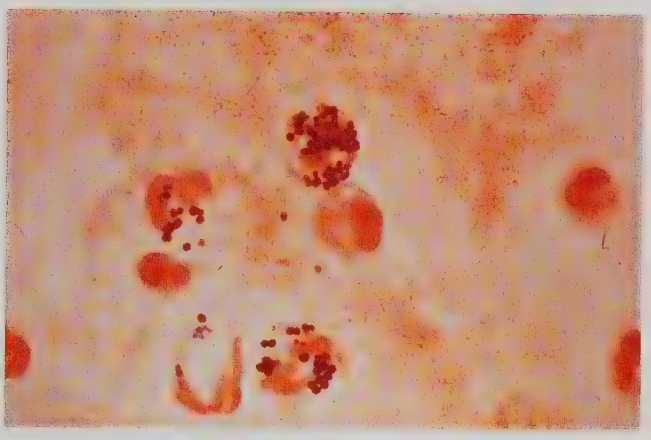


5

3 ♦ In the lung, there is no classic radiographic pattern of *Staphylococcus aureus* infection. It can present as a lobar or diffuse pneumonia, single or multiple lung abscesses, as well as pleural effusion. This chest radiograph of *S aureus* pneumonia depicts dense consolidation of the left upper lung with suspected abcess.

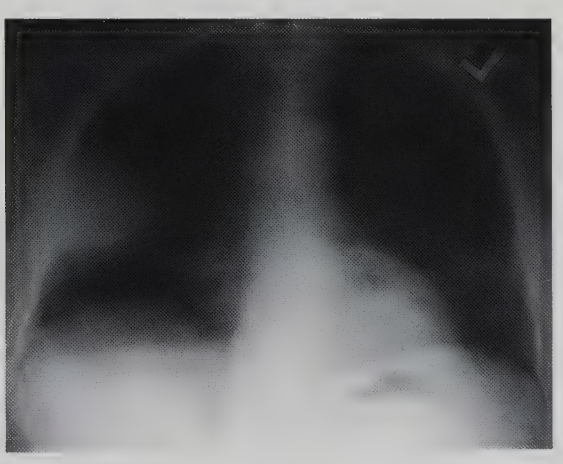
4 ♦ *Staphylococcus aureus* with pneumatoceles. These are thin-walled, cystic lesions in the pulmonary parenchyma that appear more commonly in infants than adults.

5 ♦ Bronchoalveolar lavage specimen showing intracellular *Staphylococcus aureus* associated with *S aureus* pneumonia.

6

**6 ♦** Osler node. This important physical finding of erythematous, usually painful spots on the distal fingers and toes is very suggestive of bacterial endocarditis. This specimen occurred in a patient with *Staphylococcus aureus* pneumonia and endocarditis affecting the mitral valve.

**7-8 ♦** Lobar pneumonia with *Streptococcus pneumoniae.* The lobar or segmental infiltrate on chest radiograph with *S pneumoniae* is an oft-touted "classic pattern" of presentation, although this is not consistent in all patient groups. Subsegmental or less homogeneous patterns seem more common, particularly in patients with underlying chronic lung disease.



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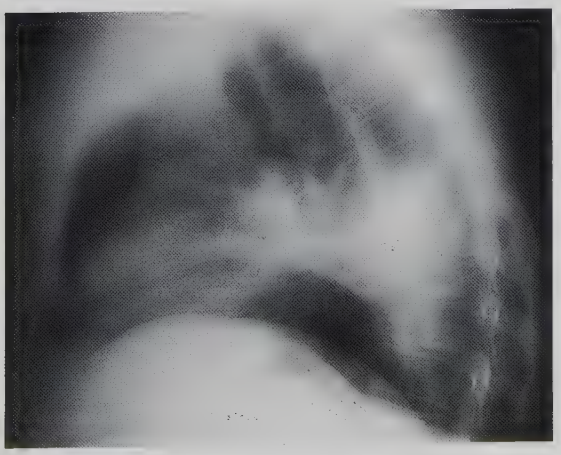

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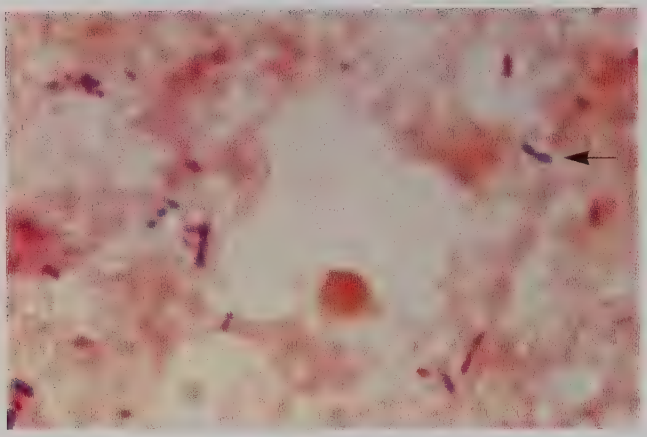
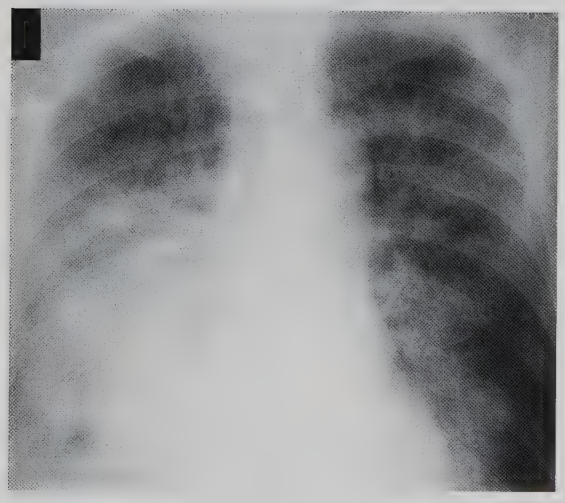


9

9 ♦ *Streptococcus pneumoniae* is a Gram-positive aerobic bacteria, appearing as diplococci or chains on sputum examination, typically surrounded by inflammatory cells. This Gram's stain emphasizes the capsule of *S pneumoniae* (see arrow). Gram's stain is a supportive diagnostic technique for the diagnosis of pneumonia in the face of a significant number of leukocytes and an insignificant number of oral epithelial cells.



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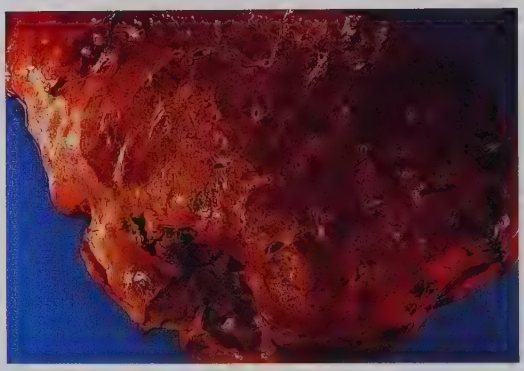
**10 ♦** *Pseudomonas aeruginosa* pneumonia with diffuse airspace involvement. The pneumonia is often bilateral, with diffuse airspace involvement on chest radiograph. A patient with *P aeruginosa* to this extent typically appears extremely toxic.



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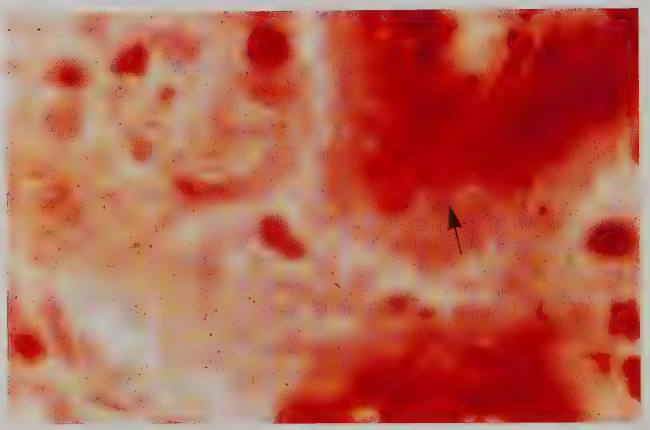
**11 ♦** Autopsy specimen showing the diffuse, hemorrhagic, parenchymal changes of *Pseudomonas aeruginosa* pneumonia. The lung lesions can appear as poorly localized, hemorrhagic areas with microscopic intra-alveolar hemorrhage and alveolar necrosis. Lung abscesses, necrotic nodules with significant leukocyte invasion, and bacterial invasion of blood-vessel walls are also described.

**12 ♦** Autopsy specimen of the lung showing diffuse *Pseudomonas aeruginosa* pneumonia notable for its multicentered, nodular, lobular appearance.

**13 ♦** Autopsy specimen of a large lung abscess with *Pseudomonas aeruginosa.*

12

13



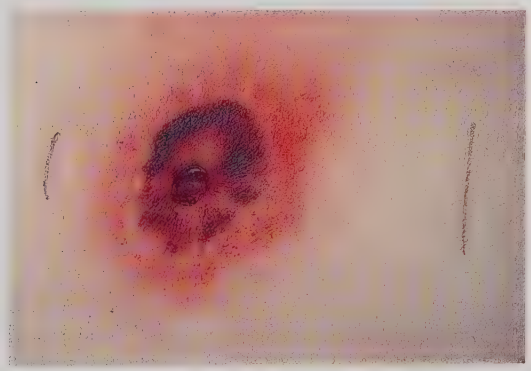
14

**14 ♦** Histologic section depicting *Pseudomonas* vasculitis of the lung. Gram-negative rods can be seen juxtaposed to the vessel wall (see arrow). This can be seen with bacteremia-induced Pseudomonas aeruginosa pneumonia.

**15 ♦** Ecthyma gangrenosum—multiple lesions in patients with *Pseudomonas aeruginosa* bacteremia. Ecthyma gangrenosum is an important distinguishing, cutaneous lesion of *Pseudomonas* bacteremia. The lesions are indurated nodules with an erythematous border that occur anywhere on the body, in single or multiple presentation. With time, vesicles and ulceration can occur. Cutaneous biopsy of the lesion can show the Gram-negative *Pseudomonas* organism both on microscopic staining as well as culture.

**16 ♦** A single lesion depicting the ulcerated appearance of ecthyma gangrenosum with the surrounding erythema.

15



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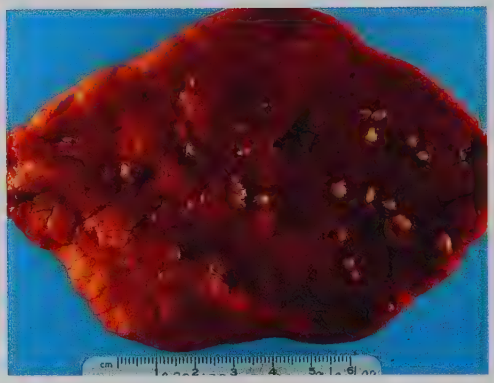


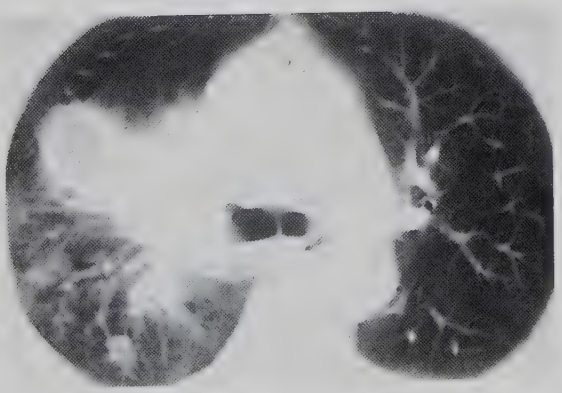
17

**17 ♦** Lung autopsy section of cystic fibrosis (CF). Of note, the mucoid variant of *Pseudomonas aeruginosa* is the predominant etiology of chronic infection. This slide is remarkable for the significant obstruction of the large airways by the tenacious secretions of CF.

**18 ♦** Cystic fibrosis and chronic *Pseudomonas aeruginosa* infection. Right upper lobe with changes consistent with bronchiectasis.

**19 ♦** A hilar mass with distal postobstructive pneumonia. This is a potential clinical setting of anaerobic pneumonia that can occur after aspiration of oral secretions or gastric contents.

18



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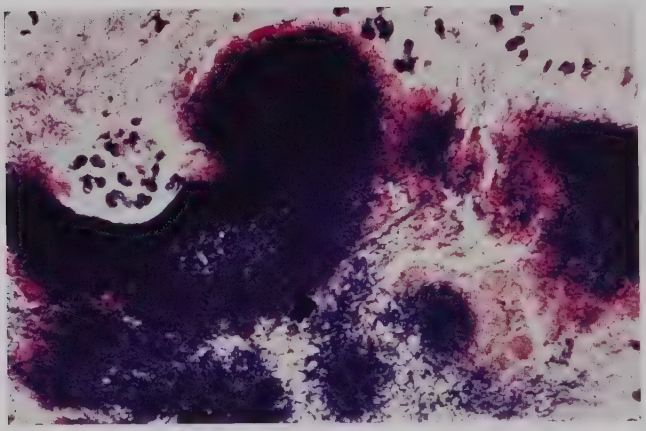

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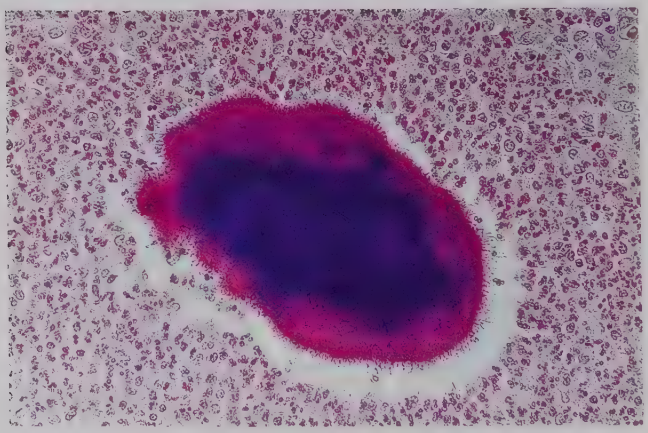

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22

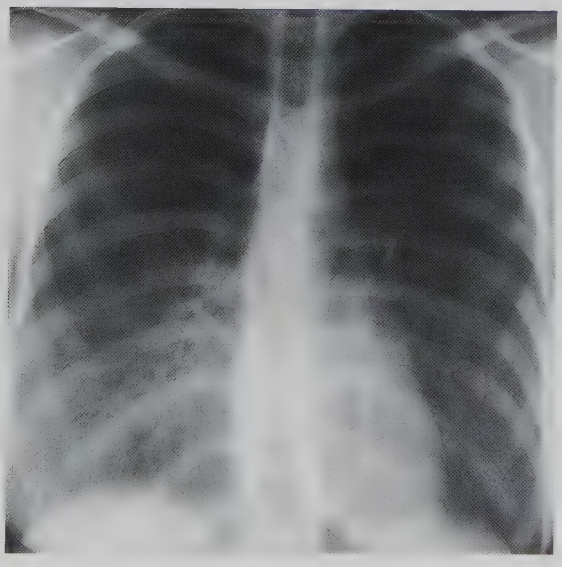
**20 ♦** Actinomycotic sulfur granule and inflammatory cells stained with Gomori methenamine-silver stain. The identification of sulfur granules with bacteriologic culture of one of the *Actinomyces* strongly supports the diagnosis of actinomycosis.

**21 ♦** Sulfur granules of *Actinomyces* are seen in the center as a delicate, black-staining, branching filament of actinomycosis. The peripheral sections of the filaments are less distinct and appear "clubbed" because they are covered by a polysaccharide-protein complex produced by the host. Sulfur granules have been described with other organisms, including *Staphylococcus* (botryomycosis), *Nocardia, Streptomyces,* and other fungi; however, they all lack the characteristic peripheral "clubbing."

**22 ♦** Gram's stain of *Actinomyces israelii,* showing the Gram-positive, delicately branched elements. The identification of these organisms alone in sputum or bronchial washing in the absence of sulfur granules is of limited significance. This bacterium can be identified in the oral cavity of noninfected individuals.

23

**23 ♦** Pulmonary parenchymal cavity secondary to chronic *Nocardia* infection. The chest radiographic findings are variable with confluent parenchymal infiltrates, thin-walled cavities, pulmonary nodules, pleural effusion, and single or multiple abscesses having been reported. Pulmonary disease is typically caused by *Nocardia asteroides*, which infects the lung through inhalation.

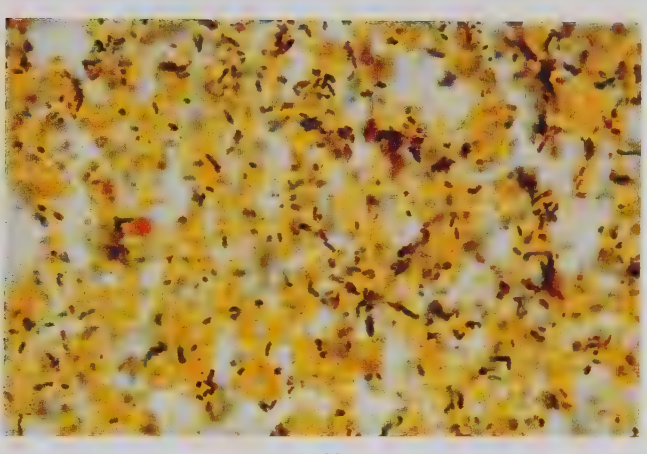


24

24 ♦ Atypical pneumonia with *Mycoplasma pneumoniae*, which is thought to be the major cause of atypical pneumonia syndromes. The appearance of the chest radiography is variable and usually reveals interstitial infiltrates, with or without concomitant alveolar consolidation.

25

25 ♦ *Legionella pneumophila* pneumonia. The appearance is generally described as airspace consolidation, usually unilateral in presentation. The disease can progress to bilateral involvement with the tendency to affect the lower lobes. Lymph node enlargement in the hilum and mediastinum is not characteristic. Pleural effusion has been reported.



26

**26 ♦** *Legionella pneumophila* can be seen clearly when stained by modified Dieterle's silver-impregnation stain. Gram's stains (Brown-Brenn and Brown Hopps) of sputum fail to show organisms.

27

28

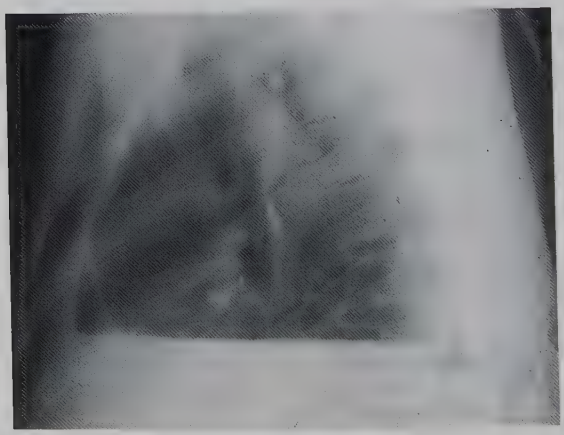
29

**27 ♦** Chronic obstructive lung disease. Multiple large emphysematous bullae and hyperinflation (posterior-anterior view).

**28 ♦** Posterior-anterior view of the patient in 27 with an acute community-acquired pneumonia of the right upper lobe. The right upper lobe infiltrate outlines the bullous disease present in the lungs; unfortunately, it also may define the amount of functioning parenchyma that the patient used for oxygenation and ventilation. The value of comparing previous chest radiographs (27) with current chest radiographs has been well documented in the workup of acute infectious pneumonia as well as solitary pulmonary nodules.

**29 ♦** Autopsy specimen of the purulent-appearing pleural collection of an empyema above the diaphragm. Empyema is typically caused by a bacterial infection that extends from an underlying pneumonia, but it can also develop postthoracotomy.

30



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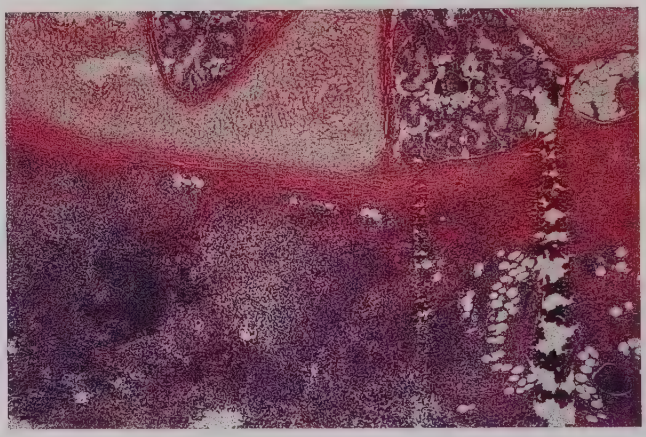
32

**30-31** ♦ Hydropneumothorax with a large air-fluid level. In these views, the pleural effusion is an empyema, with pus in the pleural space.

**32** ♦ Autopsy specimen of the significant edema that occurs with acute epiglottitis. The intense inflammatory response and progressive edema of the epiglottis and the adjacent tissues can cause complete obstruction of the airway.

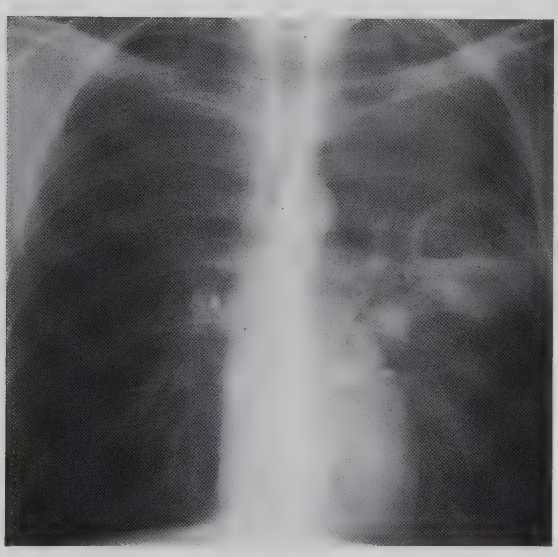


33

**33 ♦** Acute necrosis associated with acute epiglottitis (hemotoxylin-eosin, original magnification, ×25).

**34 ♦** Lung abscess in the left lung. A lung abscess typically is polymicrobial in origin, often occurring in patients with poor dentition and associated with aspiration of infected material. Lung abscesses can be associated with bronchial obstruction such as bronchogenic carcinoma as well as foreign bodies.

**35 ♦** Autopsy specimen of a lung abscess showing the well-circumscribed cavity in the upper lobe of the lung. Pathologically, this is usually a central area of necrosis within the lung parenchyma that, over time, becomes surrounded by a fibrous wall.



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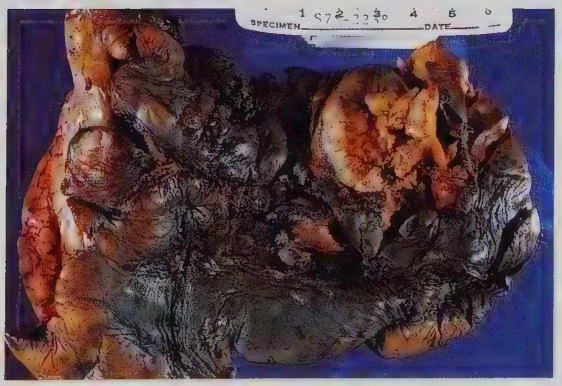


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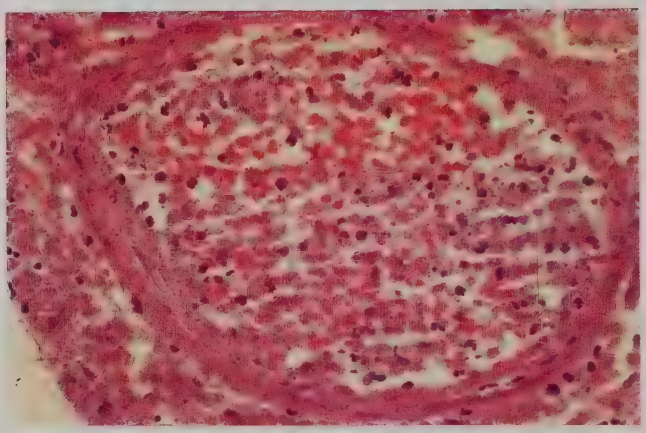

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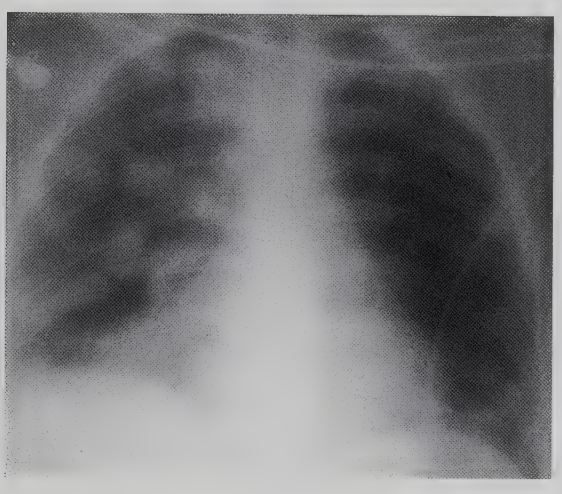
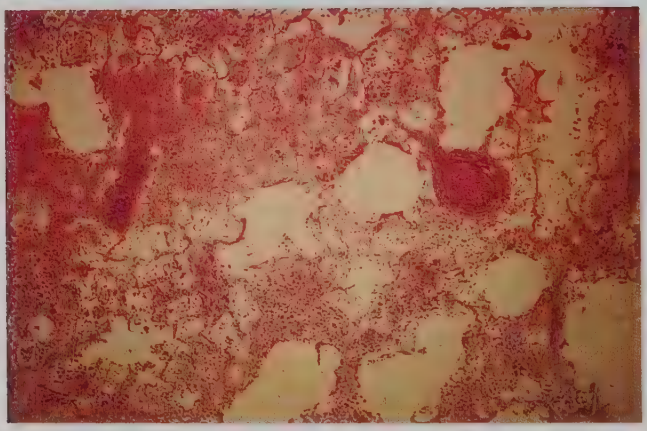
**36 ♦** Pulmonary vessel with septic emboli (hemotoxylin-eosin, original magnification, ×25). Thrombosis occurs due to either trauma or infection of the vein. The thrombosis then becomes infected and friable, resulting in small and repetitive emboli to the lung.



37

**37 ♦** Chest radiograph demonstrating multiple, bilateral, small nodular densities. This is a highly suggestive diagnostic clue of septic pulmonary emboli. The characteristic chest radiograph shows multiple, small, nodular densities with "shaggy" or "fuzzy" borders. Cavitation commonly occurs, and the number of nodules may increase as embolization continues. The septic pulmonary emboli can cause an acute necrotizing pneumonia or a purulent hemorrhagic infarct.



38

38 ♦ Lung tissue (hemotoxylin-eosin stain) with acute inflammatory pneumonitis and two blood vessels with septic pulmonary emboli.

39

**39 ♦** Lung tissue with acute inflammatory pneumonitis and microabscess formation secondary to septic pulmonary emboli (hematoxylin-eosin stain).

## *Clinical Pearls*

**1** ♦ The differential diagnosis of bilateral alveolar infiltrates on chest radiograph is extensive, including both Gram-positive and Gram-negative infections as well as noninfectious etiologies.

**2** ♦ Although some controversy exists regarding the sensitivity and specificity of the Gram's stain examination, the ready availability of samples, noninvasive nature of the test, and rapid applicability toward direction of antibiotic therapy support its continued use.

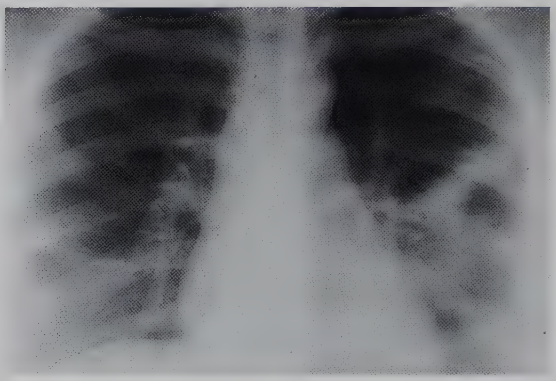
**3** ♦ In the lung, there is no classic radiographic pattern of *Staphylococcus aureus* infection. It can present as a lobar or diffuse pneumonia, single or multiple lung abscesses, as well as pleural effusions.

**4** ♦ The use of fiberoptic bronchoscopy and bronchoalveolar lavage of the involved bronchopulmonary segment, combined with protected brush-catheter biopsy for quantitative bacterial cultures, can provide for improved sensitivity in the diagnosis of pneumonia.

**5 ♦** Lung abscess is a consideration in any cavitary lesion seen on chest radiograph. The differential diagnosis is broad including infectious etiologies, developmental cysts, immunologic causes (eg, Wegener's granulomatosis), bronchogenic carcinoma, septic pulmonary emboli, and forms of occupational lung disease (eg, silicosis).

**6 ♦** Pleural-fluid features supporting the diagnosis of empyema include a positive culture of pathogens, a positive Gram's stain, positive exudative characteristics, and leukocytosis.

**7 ♦** The characteristic chest radiographic appearance of septic pulmonary emboli is multiple small nodular densities with "shaggy" or "fuzzy" borders.



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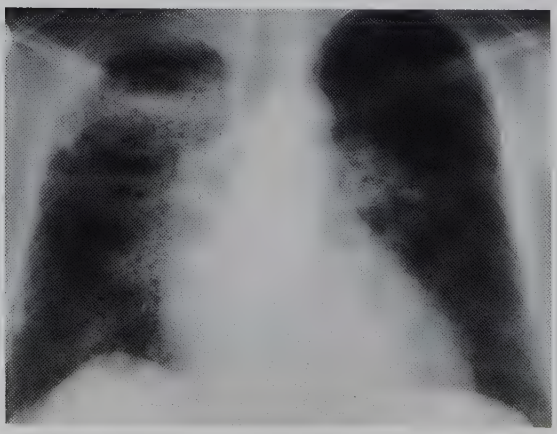

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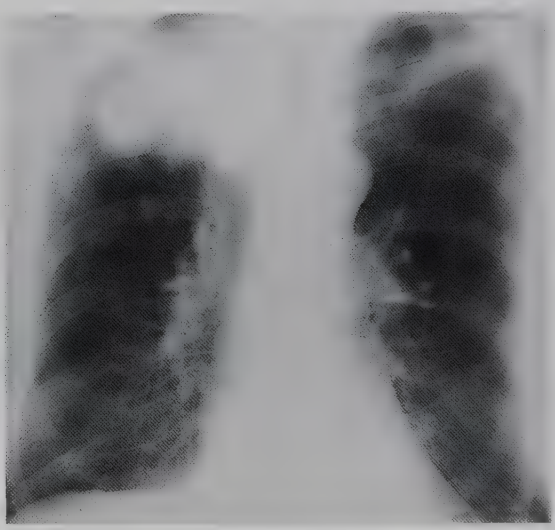
42

**40** ♦ Characteristic gloved–finger infiltrate of allergic bronchopulmonary aspergillosis—a hypersensitivity disease occurring only in asthmatics and caused by the *Aspergillus* antigen. *Aspergillus* organisms are found in mucous plugs but do not invade the bronchial walls. Central saccular bronchiectasis may develop in longstanding disease.

**41** ♦ A right upper lobe cavity and diffuse pulmonary fibrosis with honeycomb changes. A fungal ball is seen inside the cavity. The interstitial fibrosis is secondary to pulmonary sarcoidosis.

**42** ♦ Mass of *Aspergillus* mycelial elements from an aspergilloma (Grocott stain). Aspergillomas are masses of *Aspergillus* organisms growing inside existing lung cavities. There may be an intense inflammatory reaction around the cavity, but the fungus does not invade the walls.



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43 ♦ Lobar consolidation of the right upper lobe. In the immunocompromised host, the differential diagnosis of this infiltrate is extensive. In this case, the diagnosis was aspergillosis.

44 ♦ Lung section with a necrotizing bronchopneumonia due to invasive aspergillosis. This is the classic clinical presentation. *Aspergillus* organisms can be found invading pulmonary blood vessels, causing infarction and pulmonary hemorrhage.

45 ♦ Trachea with multiple ulcerative lesions secondary to invasive aspergillosis. Tracheobronchitis, cavity formation, miliary disease, and interstitial pneumonitis have also been reported. Dissemination can occur to the gastrointestinal tract, brain, liver, spleen, kidney, heart, and skin.

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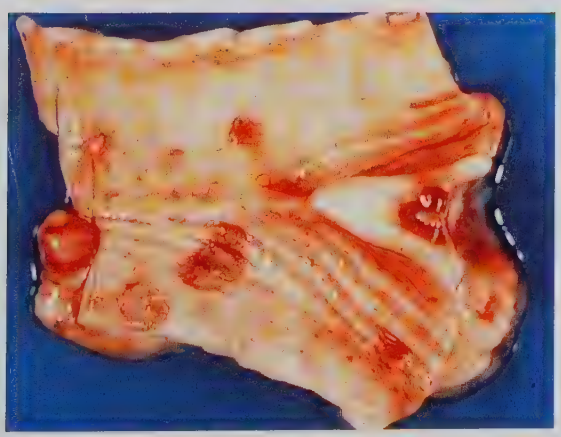

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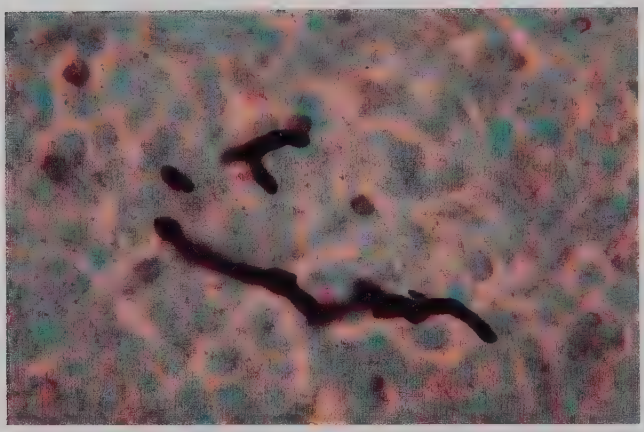

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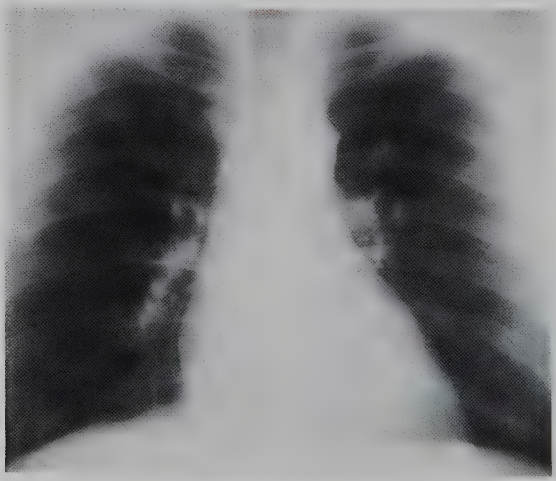
48

46 ♦ Lung tissue with septate, acute-angle, branching *Aspergillus hyphae* (Grocott stain).

47 ♦ Lung tissue with cluster of *Aspergillus* hyphae (Grocott stain). The *Aspergillus* hyphae are narrow and septate; they branch at acute angles. Evidence of tissue invasion by *Aspergillus* hyphae is diagnostic for invasive disease. *Aspergillus* hyphae can also be found in the mucous plugs of allergic bronchopulmonary aspergillosis and the intracavitary mass of aspergilloma.

48 ♦ Ulcerative appearance of biopsy-proven blastomycosis involving a distal extremity. The skin lesion begins as a papule or nodule with development of a verrucous surface. With time, it expands peripherally, developing a ring- or horseshoe-shaped appearance. The peripheral edges are raised, often with small pustules present.

49



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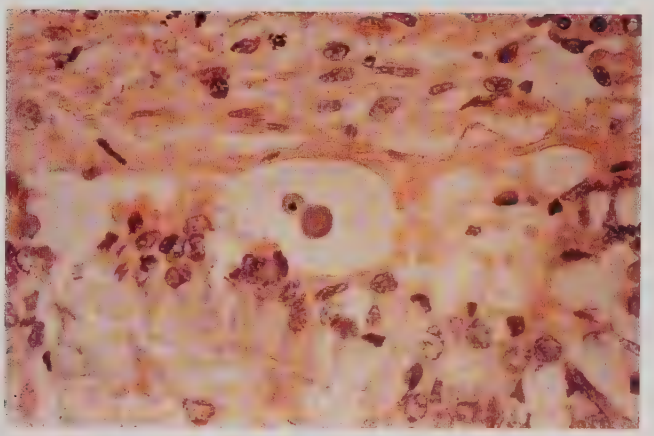


51

**49 ♦** Skin lesion affecting the tip of the nose with biopsy-proven blastomycosis. Skin infection is the most common extrapulmonary manifestation, occurring in 40% to 80% of cases.

**50 ♦** Blastomycosis with a localized infiltrate in the left upper lobe.

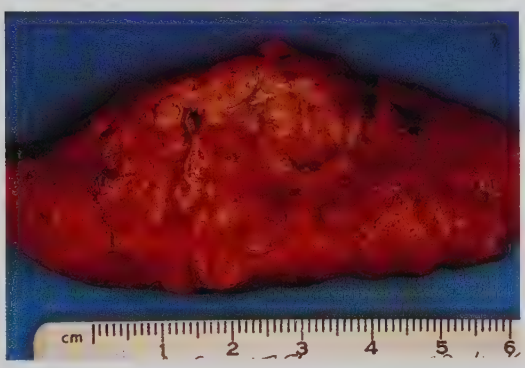
**51 ♦** North American blastomycosis (hemotoxylin-eosin stain). The organism's morphologic appearance shows round, budding yeast. Note that the base of the budding yeast is broad as compared with the narrow-based bud of *Cryptococcus neoformans* (See 67, 68).

52

52 ♦ Blastomycosis (Grocott stain).

53 ♦ Lung section demonstrating pulmonary candidiasis with a necrotizing bronchopneumonia and abscess formation.

54 ♦ Disseminated candidiasis with diffuse patchy airspace consolidation. The characteristic radiographic appearance of disseminated candidiasis is bilateral patchy, homogenous, poorly defined areas of airspace consolidation. A diffuse nodular pattern, cavitation, and mycetoma formation have also been reported.

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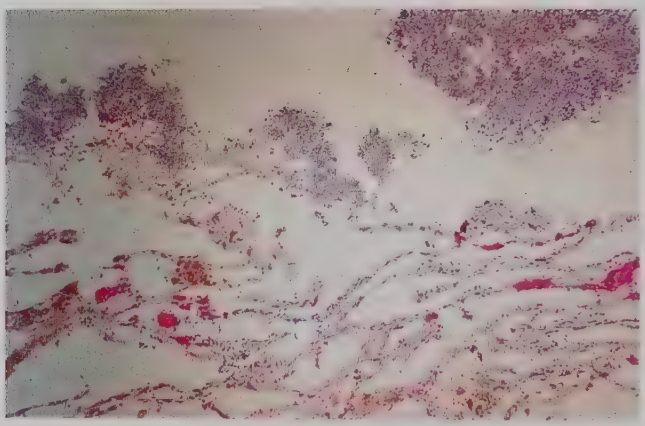

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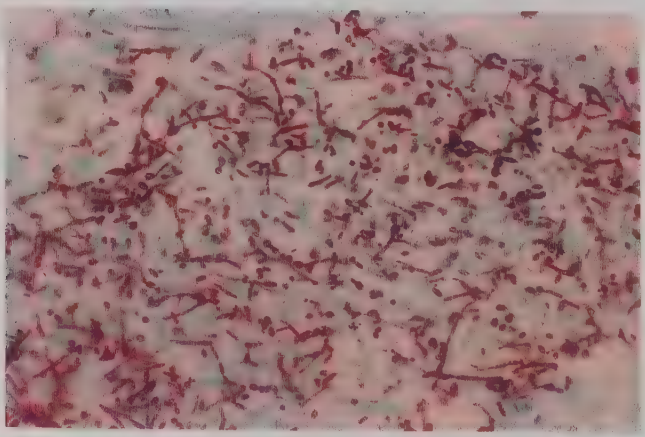

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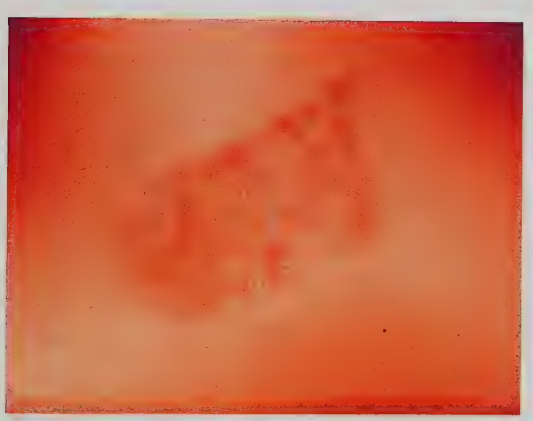
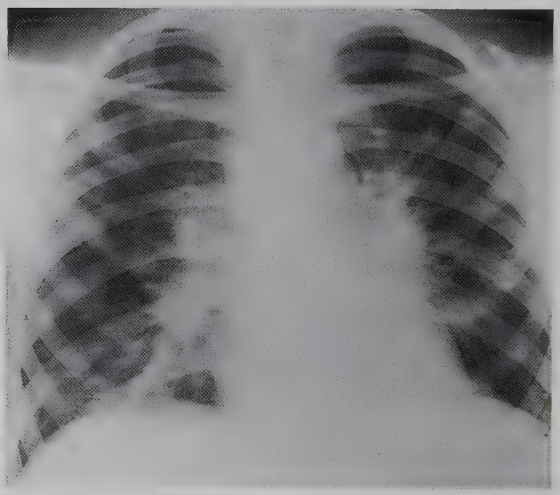


57

55 ♦ Colonies of *Candida albicans* in lung tissue. Culture results may not be reliable in making a diagnosis since the fungus is part of the normal human flora.

56 ♦ *Candida* yeast and hyphae in lung tissue. Diagnosis is usually made by demonstration of invasive organisms on tissue biopsy. Many cases are not diagnosed until autopsy.

57 ♦ Cutaneous manifestation of primary coccidioidomycosis. Erythema nodosum or erythema multiforme are the common cutaneous manifestations of primary disease and are positive prognostic indicators against dissemination.



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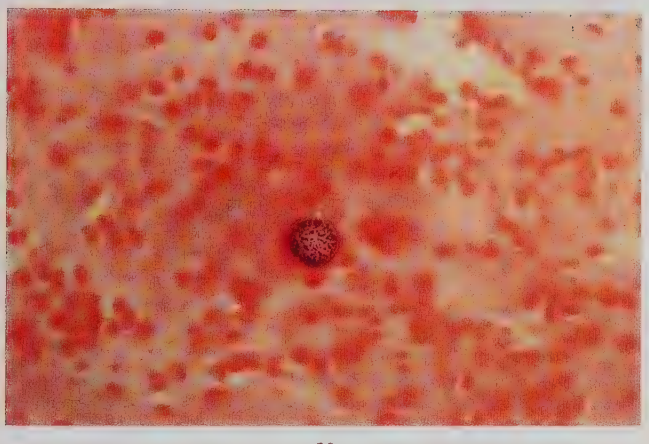
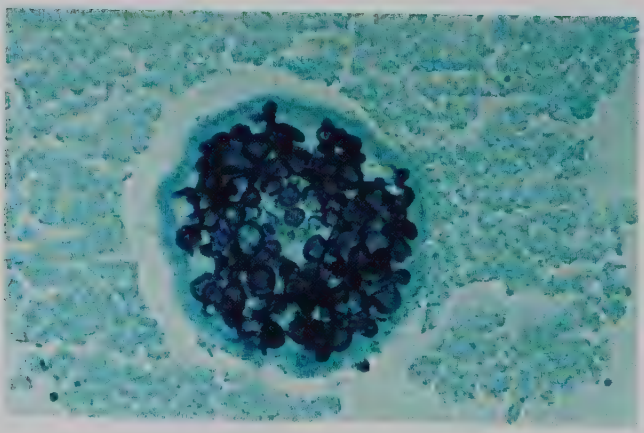
58 ♦ Primary coccidioidomycosis with bilateral multiple, thin-walled cysts with upper lung zone predominance. In general, the chest radiographic findings are nonspecific and may be more prominent than the clinical symptoms.



59

**59 ♦** *Coccidioides immitis* spherule in lung tissue (hematoxylin-eosin stain).

60



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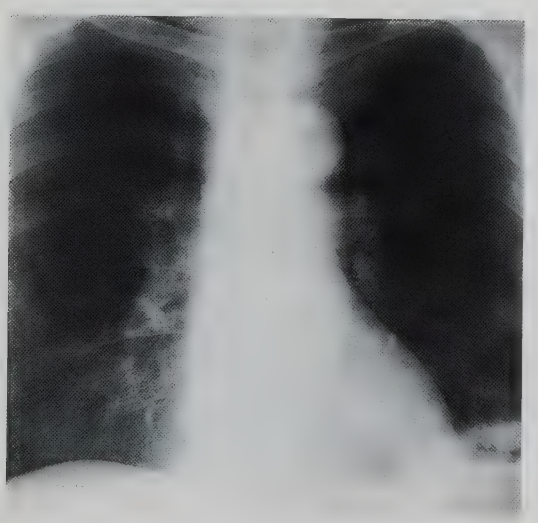
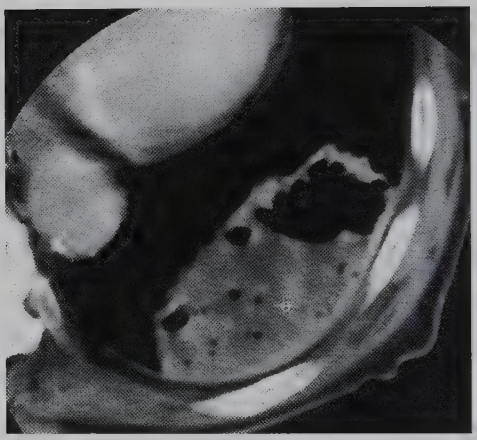


62

**60-61 ♦** *Coccidioides immitis* spherule in lung tissue (Grocott stain). The *C immitis* spherule may be found in sputum or bronchoalveolar lavage specimens.

**62 ♦** Patient with a hematologic malignancy and primary pulmonary cryptococcosis. Note the left lower lung field mass. The most common chest radiograph finding is a solitary pleural-based mass; other findings include solitary or multiple nodules, an ill-defined area of pulmonary consolidation, or a diffusely disseminated miliary pattern.



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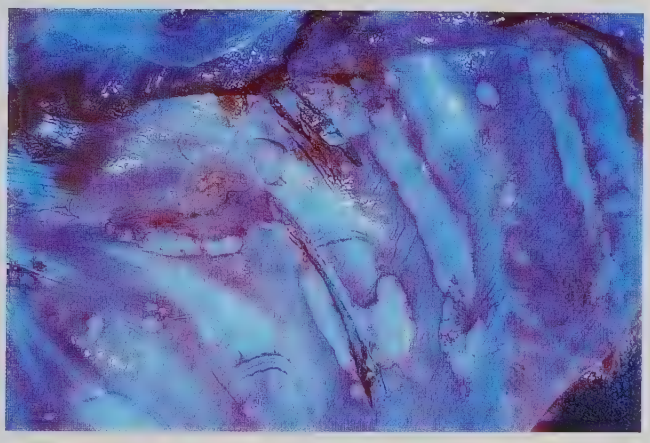


65

**63** ♦ Left lower lobe cavitary lesion caused by *Cryptococcus* shown on a computed tomography scan.

**64** ♦ Lung tissue with abscess formation secondary to *Cryptococcus neoformans.*

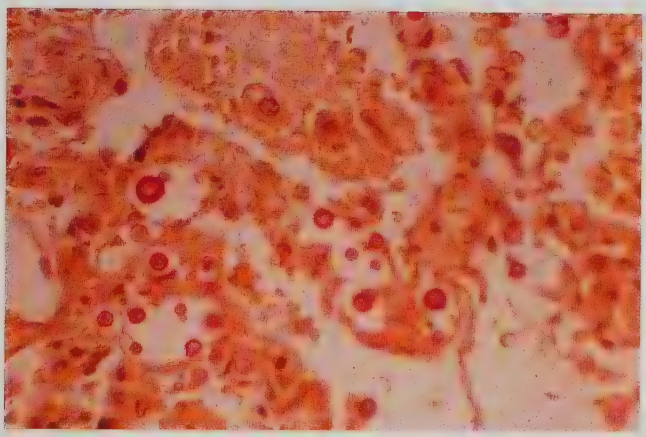
**65** ♦ Multiple pleural plaques in a patient with disseminated cryptococcosis.

66

**66** ♦ Cellulitis due to disseminated cryptococcosis. There are no specific skin findings of cutaneous cryptococcosis; however, its presence is significant for the early diagnosis of disseminated disease. Painless papules and draining ulcers are common cutaneous manifestations.

**67** ♦ Encapsulated yeast of *Cryptococcus neoformans* in lung tissue (mucicarmine stain). The organism is best identified on biopsy specimens using mucicarmine or silver stains.

**68** ♦ Encapsulated yeast of *Cryptococcus neoformans* in lung tissue (hematoxylin-eosin stain).



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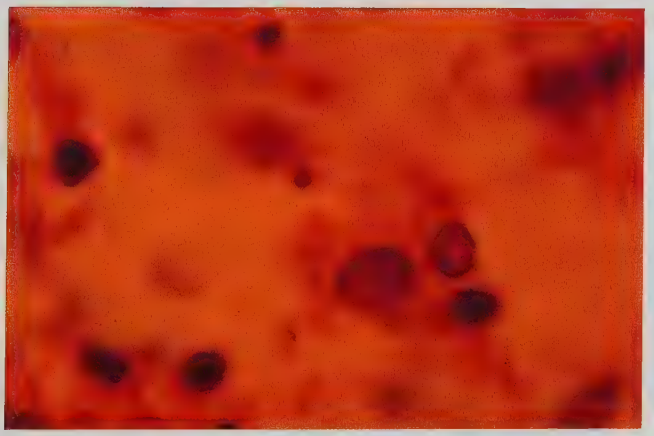

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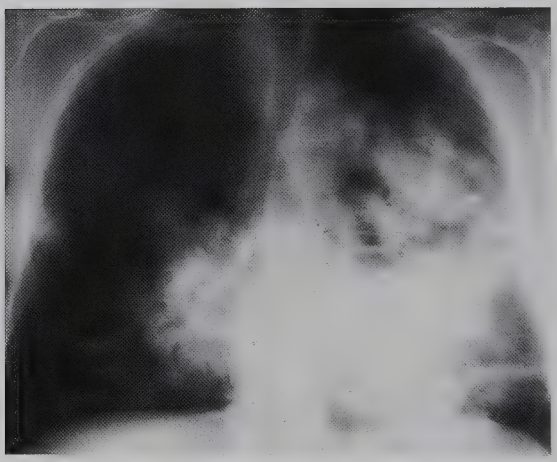

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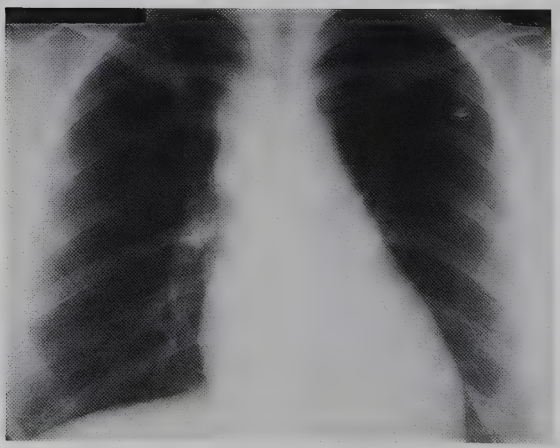

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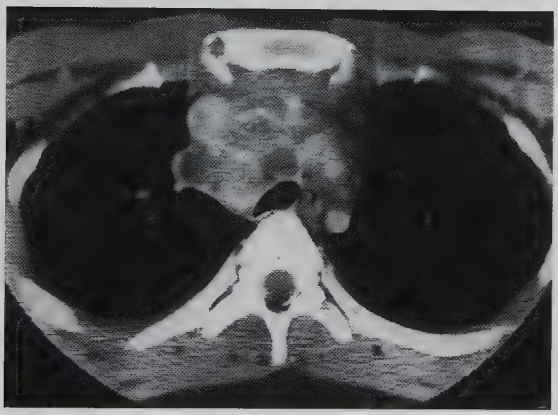
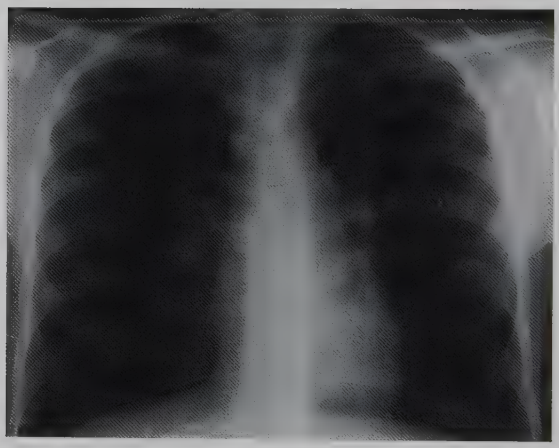


71

**69** ♦ Acute primary histoplasmosis. A patchy area of pneumonitis either with or without hilar adenopathy is a common radiographic finding. Persons exposed to a high concentration of organisms may demonstrate a diffuse nodular infiltrate. In most cases, the chest radiograph returns to normal.

**70** ♦ Chest radiographic findings suggestive of mediastinal enlargement with the final diagnosis of histoplasmosis mediastinitis. Mediastinal fibrosis is an uncommon complication that may cause vascular compression. This is the most common nonmalignant cause of superior vena cava syndrome.

**71** ♦ Histoplasmosis mediastinitis. Significant mediastinal lymphadenopathy and edema shown on computed tomography scan of the chest.



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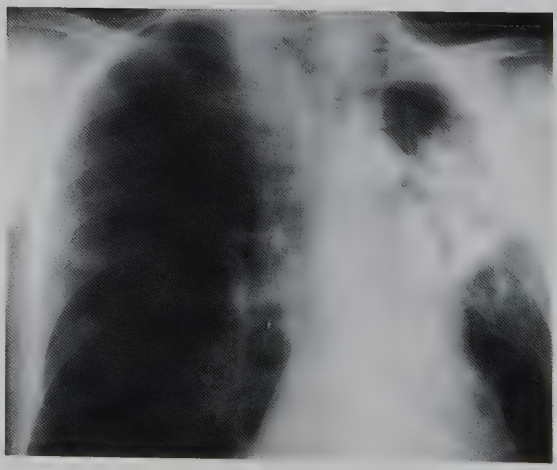

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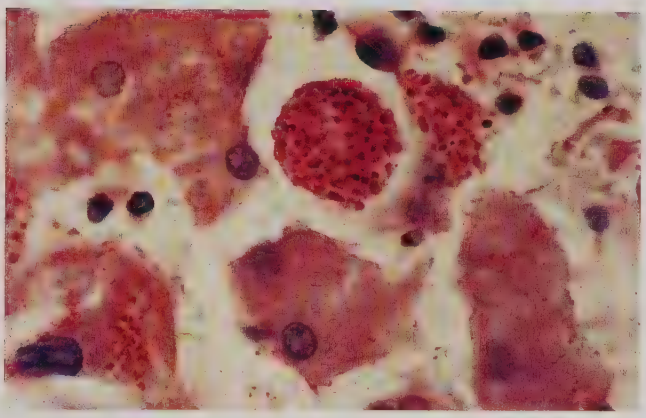
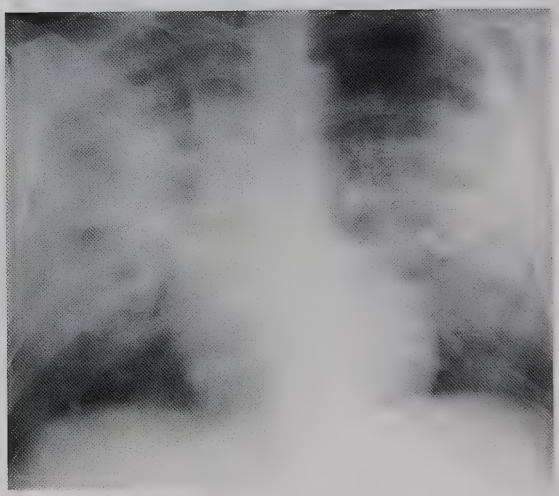


74

72 ♦ Pulmonary histoplasmosis with calcified nodules. Target lesions are calcified pulmonary nodules (either solitary or multiple) that can occur after the resolution of primary pulmonary histoplasmosis. Multiple, smaller "buckshot" calcifications usually indicate an exposure to a larger inoculum of fungus. Calcified hilar lymph nodes may also be found.

73 ♦ Pulmonary histoplasmosis with cavitary disease. Chronic cavitary histoplasmosis is the result of primary disease in structurally abonormal lungs such as those affected by centrilobular emphysema. Some patients develop a progressive fibrosing and cavitary process usually in the upper lobes, and, unless treated, this infection will continue to cause adjacent parenchyma destruction.

74 ♦ Liver biopsy showing histoplasmosis (periodic acid-Schiff stain) in disseminated disease. Hepatic involvement can occur in both acute and chronic disseminated disease.

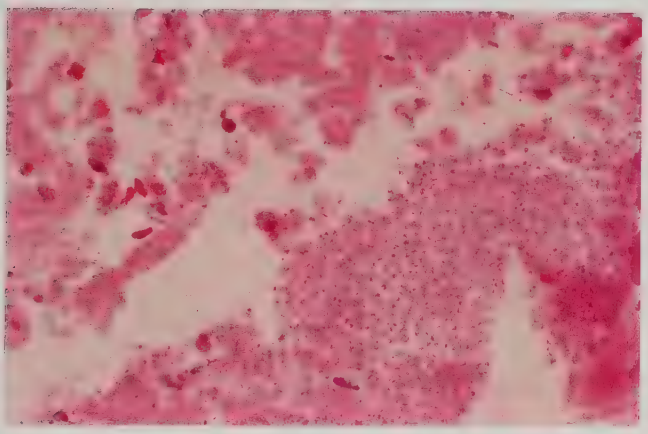


75

**75 ♦** Disseminated pulmonary histoplasmosis with bilateral alveolar infiltrates. A miliary interstitial infiltrate is the usual chest radiograph finding.

**76 ♦** Lung tissue with *Histoplasma capsulatum* (hematoxylin-eosin stain). Lung biopsy in primary pulmonary histoplasmosis usually demonstrates a pneumonitis containing macrophages, lymphocytes, and occasional multinucleated giant cells. Granuloma formation can occur. The yeast cells may be seen in clusters inside macrophages or clumped in the tissue.

**77 ♦** Lung tissue with *Histoplasma capsulatum* (hematoxylin-eosin stain).



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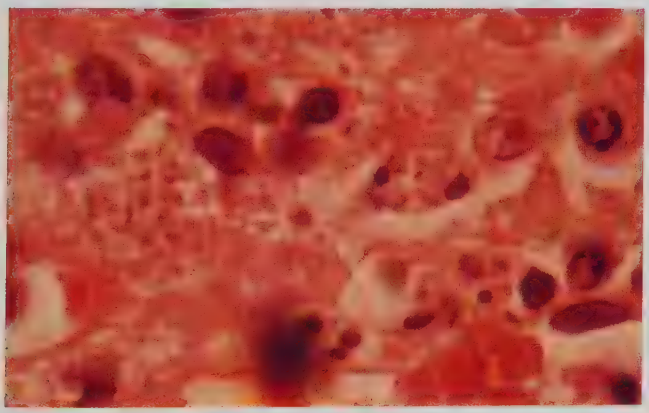

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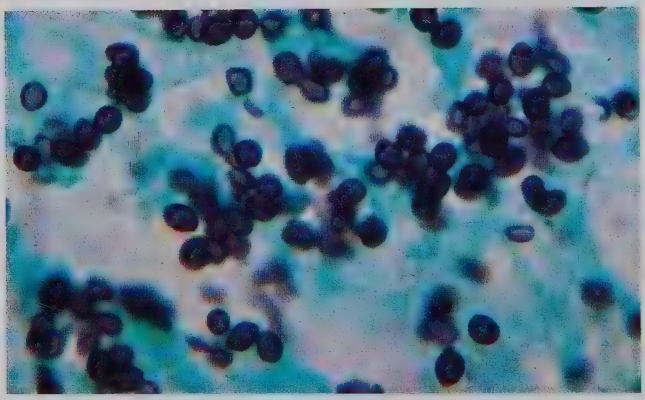


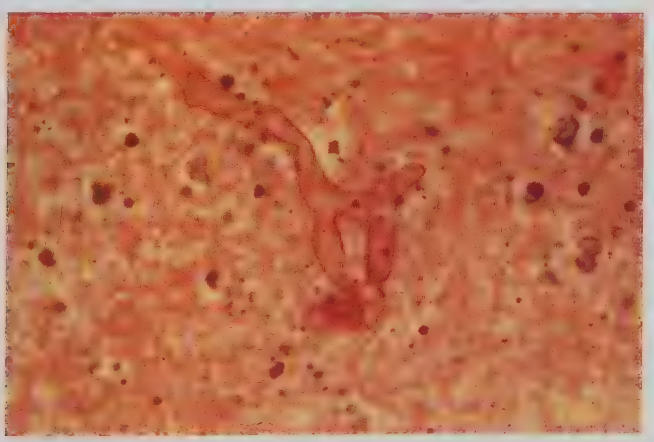
78

78 ♦ Lung tissue with *Histoplasma capsulatum* (Grocott stain). Grocott or periodic acid-Schiff staining is useful for optimal identification of the organism.

79 ♦ Right middle lobe of lung with organizing bronchopneumonia and abscess formation due to mucormycosis. Pulmonary mucormycosis can present as a lobar or bronchopneumonia, solitary lung nodule, lung abscess, or pulmonary infarction due to vascular invasion and thrombosis of the blood vessel. The infection can extend along tissue planes and involve the heart, diaphragm, or mediastinum.

80 ♦ Mucormycosis with broad, right-angle branching, nonseptate fungal hyphae in lung tissue (hematoxylin-eosin stain). Diagnosis is made by histologic examination of the affected tissue. The fungal hyphae are characteristically broad and nonseptate and have right-angle branching; they can be found growing in both viable and necrotic tissue, invading blood vessels, or extending along tissue planes.

79



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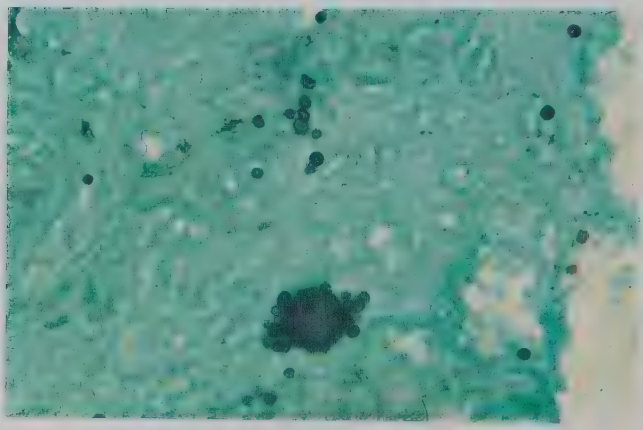

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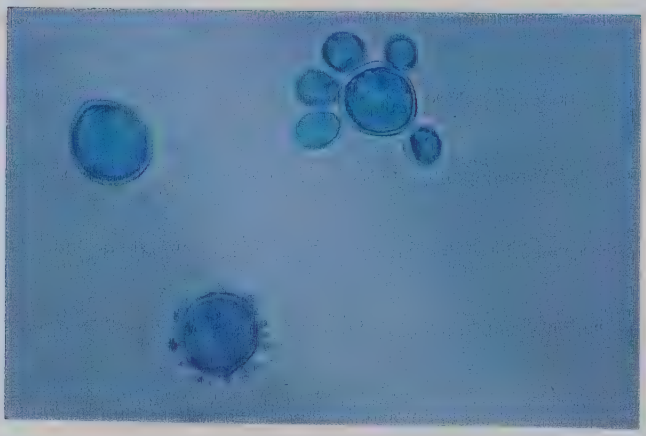

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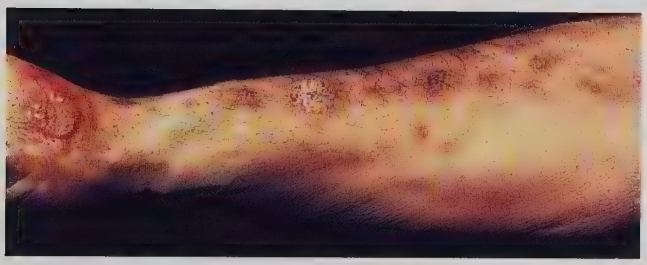
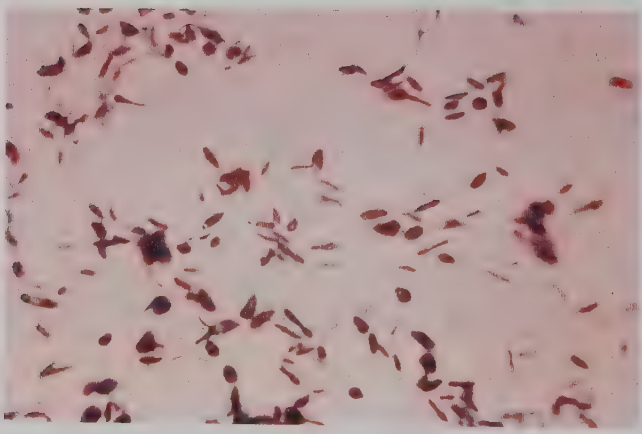


83

81 ♦ *Paracoccidioides brasiliensis* fungus cell with characteristic budding in lung tissue (Original magnification, ×200). The pulmonary manifestations are diverse and can present in any of the following forms: solitary or multiple nodules with or without cavitation, miliary nodules, interstitial fibrosis, or an acute, rapidly progressive necrotizing pneumonia. The latter is more commonly seen in immunocompromized hosts. Cor pulmonale can develop due to progressive pulmonary fibrosis.

82 ♦ Wet mount of *Paracoccidioides brasiliensis* culture showing diagnostic peripheral budding. Diagnosis can be made via sputum smear or culture. The multiple, narrow-necked buds on the periphery of the fungus cell give it the characteristic appearance of a "pilot's wheel." Positive cultures can also be obtained from skin or mucous membrane lesions.

83 ♦ The primary cutaneous inoculation of sporotrichosis affecting the extremities. The skin lesions have an erythematous, papulonodular appearance that can appear smooth as well as verrucous in nature.



84

84 ♦ Nodular aspirate of a cutaneous lesion. The Gram's stain shows numerous Gram-positive, cigar-shaped organisms.

## Clinical Pearls

**1** ♦ The four major findings required for the diagnosis of bronchopulmonary aspergillosis include:

a) recurrent pulmonary infiltrates;
b) blood or sputum eosinophilia;
c) asthma; and
d) immediate and late dermal hypersensitivity to *Aspergillus* antigens.

The characteristic chest radiograph appearance is a gloved-finger infiltrate. The one variety of bronchopulmonary aspergillosis with negative serum precipitins is invasive aspergillosis. Allergic bronchopulmonary aspergillosis, aspergilloma, and chronic necrotizing aspergillosis all have positive serum precipitins.

**2** ♦ Aspergillosis hyphae are narrow, septate, and have acute-angle branching; mucor hyphae are broad, nonseptate, and have right-angle branching.

**3** ♦ The blastomycosis skin lesion begins as a papule or nodule with development of a verrucous surface. With time, it expands peripherally, developing a ring- or horseshoe-shaped appearance.

*Continued on next page*

Clinical Pearls *cont.*

**4** ♦ Multiple chest radiographic presentations of North American blastomycosis have been reported and include: a) pneumonia with alveolar infiltrate, occurring in both upper and lower lobes; b) pulmonary parenchymal mass lesions (single or multiple), which may cavitate; c) hilar and mediastinal node enlargement; d) pleural effusion; and e) diffuse airway involvement with disseminated disease.

**5** ♦ The characteristic radiographic appearance of disseminated candidiasis is bilateral patchy, homogenous, poorly defined areas of airspace consolidation.

**6** ♦ The finding of erythema nodosum or erythema multiforme in the setting of primary pulmonary coccidioidomycosis is a positive prognostic indicator against dissemination. A solitary peripheral nodule, single or multiple thin-walled cavities, or airspace consolidation are the usual chest radiographic findings of primary coccidioidomycosis; apical fibronodular cavitary lesions are the usual findings in chronic, progressive coccidioidal pneumonia.

85

85 ♦ Lung section with echinococcal cyst. The smooth yellow-white fibrotic capsule or exocyst is visible. The larvae become trapped in either the liver or lungs and develop into solitary or multiple cysts. The pulmonary echinococcal cysts are characteristically solitary, sharply demarcated, spherical or oval shaped, and surrounded by atelectatic lung tissue. The cyst is composed of two layers—a protective outer membrane or exocyst, and an inner germinal layer or endocyst.

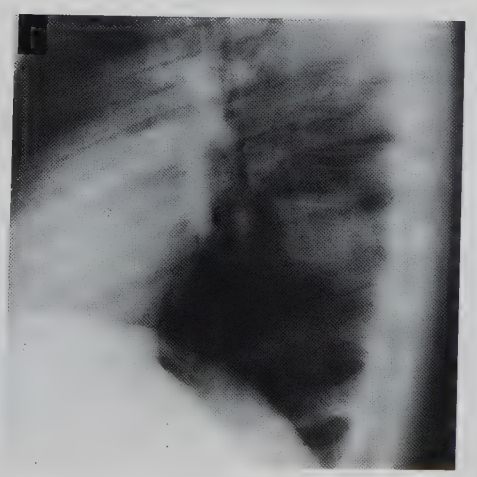
86

86 ♦ Lung section with echinococcal cyst. The cyst has been opened to reveal the interior layer or endocyst. The cyst contains fluid and brood capsules with larval scoleces. Daughter cysts may develop from the exocyst, resulting in a multicystic appearance.

87 ♦ Solitary mass in the posterior right lower lung field (posterior-anterior view). The characteristic radiographic appearance of *Echinococcus granulosus* is a solitary, well-defined, round or oval mass surrounded by normal lung, typically in the right posterior lower lobe. A crescent or meniscus sign indicates communication between the cyst and bronchial tree causing a thin layer of air around the periphery of the cyst. Air-fluid levels may also be seen inside the mass.

88 ♦ *Echinococcus granulosus.* Solitary mass in the posterior right lower lung field (lateral view).

87



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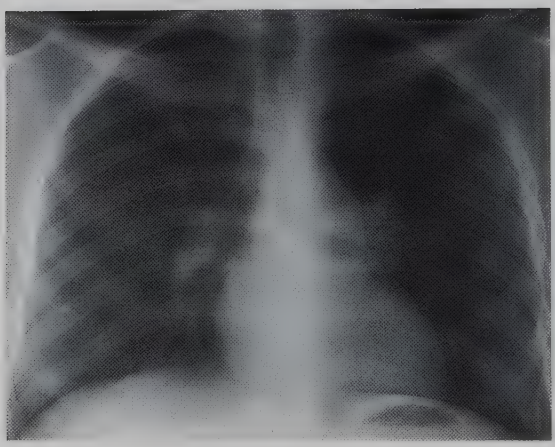

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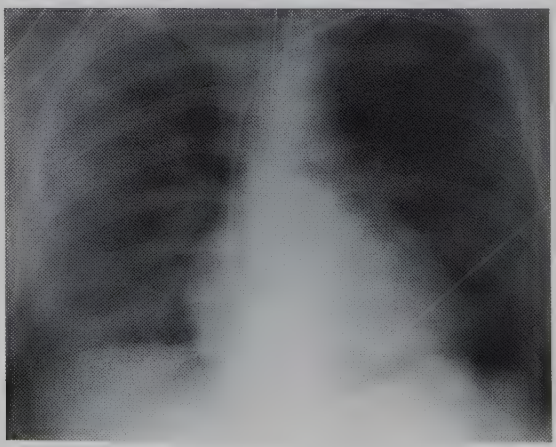

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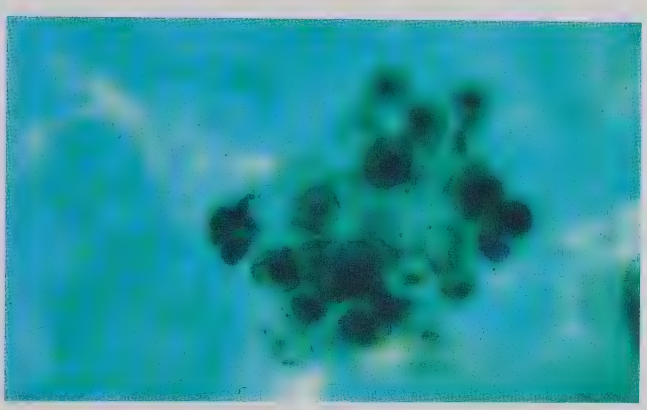


91

89 ♦ *Pneumocystis carinii.* A posterior-anterior view without significant infiltrate in a patient with acquired immunodeficiency syndrome. The more typical presentation is bilateral diffuse interstitial infiltrates in a perihilar distribution. Alveolar and interstitial infiltrates usually are associated with more severe disease.

90 ♦ Anterior-posterior view with diffuse bilateral alveolar and interstitial infiltrates due to *Pneumocystis carinii* in a young patient with acute respiratory failure.

91 ♦ *Pneumocystis carinii* organisms. The diagnosis is established with the demonstration of organisms in respiratory tract secretions or lung tissue. The sputum or bronchoalveolar lavage fluid is prepared using either Giemsa, methenamine-silver, or immunofluorescent staining. Transbronchial biopsy may be necessary if the sputum and lavage are nondiagnostic. The use of aerosolized pentamidine can lower the yield from respiratory tract secretion.

## *Clinical Pearls*

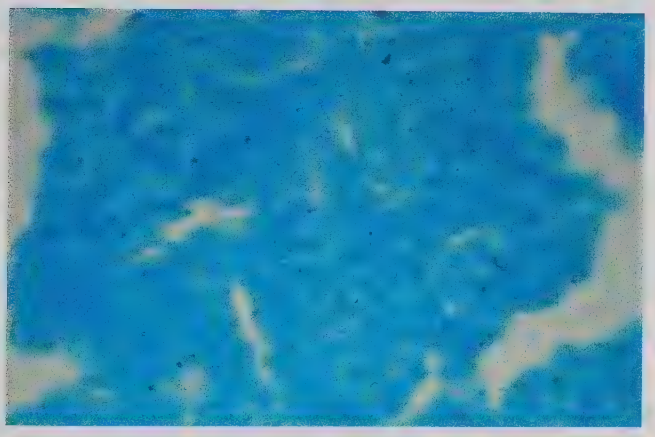
**1** ♦ Echinococcal cysts are found in both the liver and lungs, with symptoms usually related to their rupture.

**2** ♦ The crescent or meniscus sign is a radiographic finding indicating communication of the echinococcal cyst with the bronchial tree. Air is seen outlining the periphery of the cyst.

**3** ♦ A normal-appearing chest radiograph does not rule out the presence of *Pneumocystis carinii* pneumonia (PCP).

**4** ♦ Chest radiographic findings of PCP include:
- a) bilateral alveolar infiltrates
- b) solitary nodule
- c) lobar consolidation
- d) thin-walled pneumatoceles
- e) spontaneous pneumothorax.

**5** ♦ Prophylactic aerosolized pentamidine therapy is associated with spontaneous pneumothorax and upper lobe disease.



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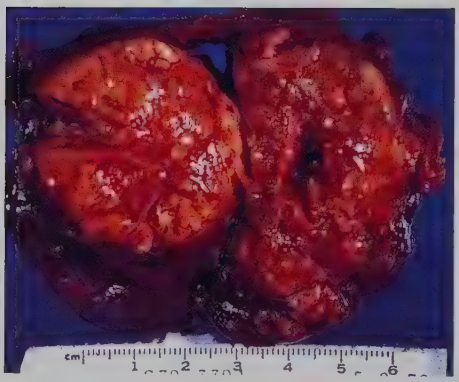
92 ♦ *Mycobacterium tuberculosis* organism using an acid-fast stain. Typically, the Gram's stain of *M tuberculosis* is weakly Gram-positive or colorless.

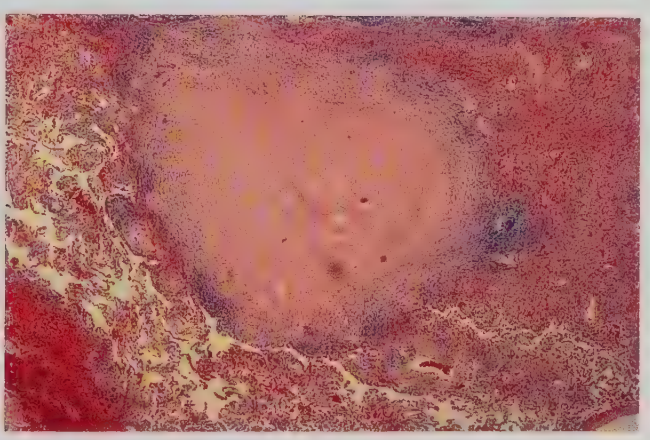



93

**93** ♦ Caseating, necrotic nodule of *Mycobacterium tuberculosis* from a lung biopsy.

**94** ♦ Caseating, necrotic nodule of *Mycobacterium tuberculosis* (hematoxylin-eosin).

**95** ♦ Autopsy section of calcified hilar lymph nodes with *Mycobacterium tuberculosis.*



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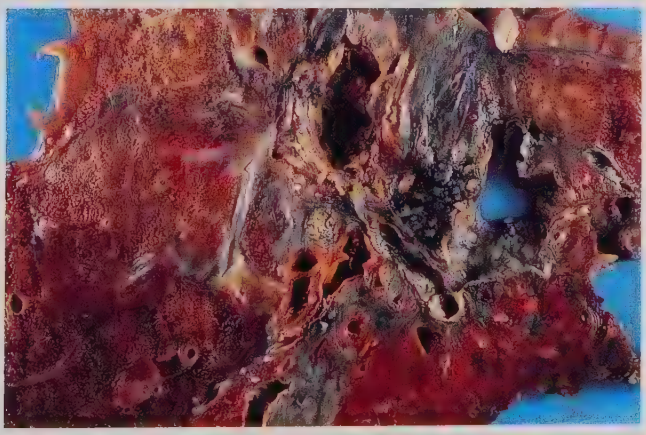


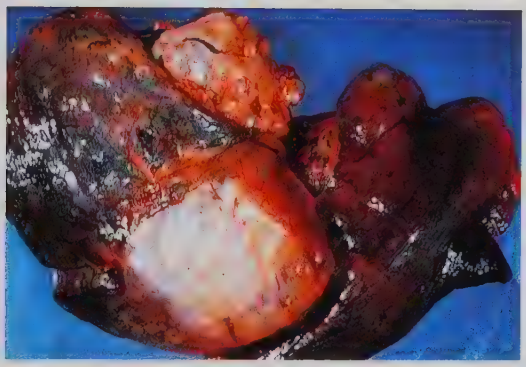
95

96

**96 ♦** Classic biapical cavitary lesions of *Mycobacterium tuberculosis.* Tuberculosis can affect areas of the lung other than the apical areas.

**97 ♦** *Mycobacterium tuberculosis* pleurisy. Pleural infection by *M tuberculosis* is associated with an exudative pleural effusion that usually shows a lymphocytic cell population with thoracentesis.

**98 ♦** Autopsy lung section depicting miliary tuberculosis, representative of hematogenously spread progressive, disseminated mycobacterial disease.



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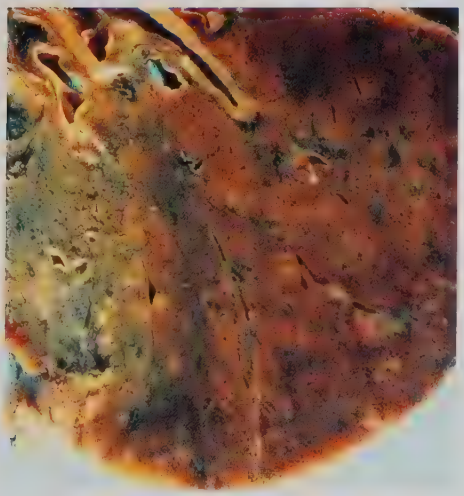
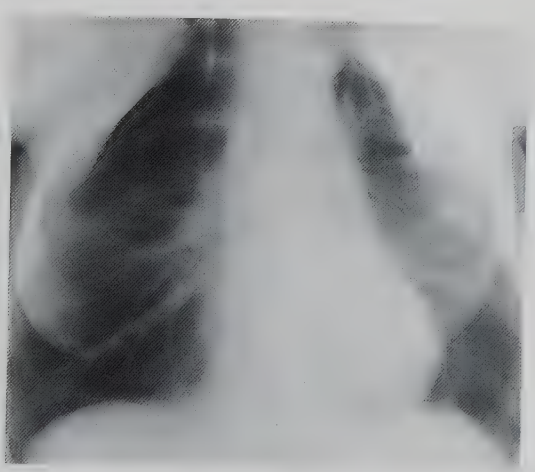


98

99

**99 ♦** Miliary tuberculosis.

**100-101 ♦** Previous surgical therapy of *Mycobacterium tuberculosis.* Before the development of antituberculous drug therapy, various surgical techniques, including thoracoplasty and plumbage, were developed to collapse the *M tuberculosis* cavities.



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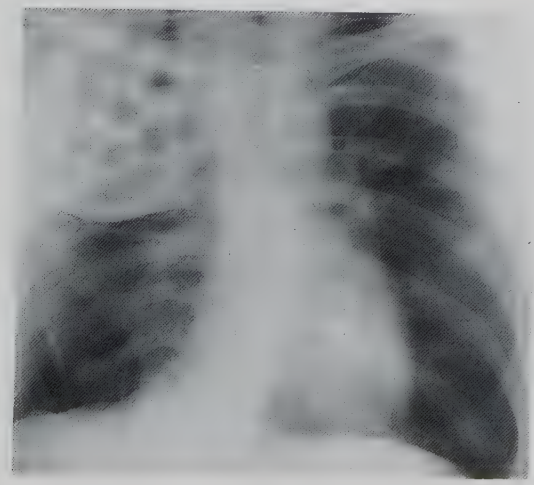
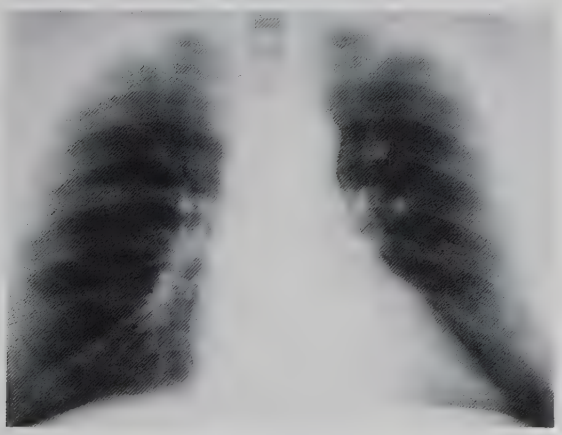


101

102

**102 ♦** Autopsy section of cavitary lung lesion of *Mycobacterium tuberculosis.*

**103-106 ♦** Radiographic progression of the primary infection of *Mycobacterium tuberculosis.* The initial infection is usually in the midlung zone. Single or multiple foci of infection occur. The Ghon complex refers to the initial focus of the infection in the lung parenchyma. The Ranke complex refers to the combination of the Ghon complex with extension of the infection to the regional hilar lymph nodes. Over time, the patient showed the development of a right lower lobe infiltrate with progressive enlargement and calcification of the right hilar lymph nodes.



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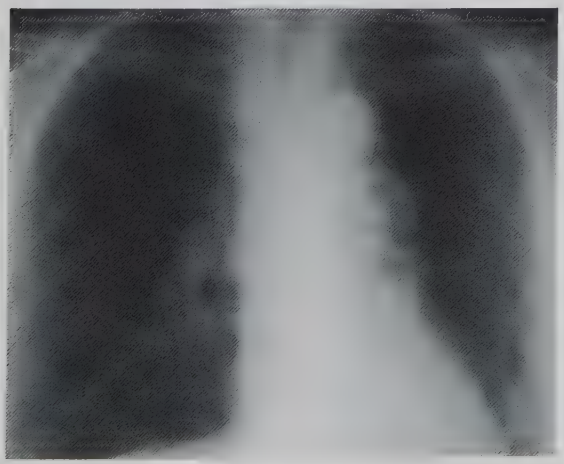

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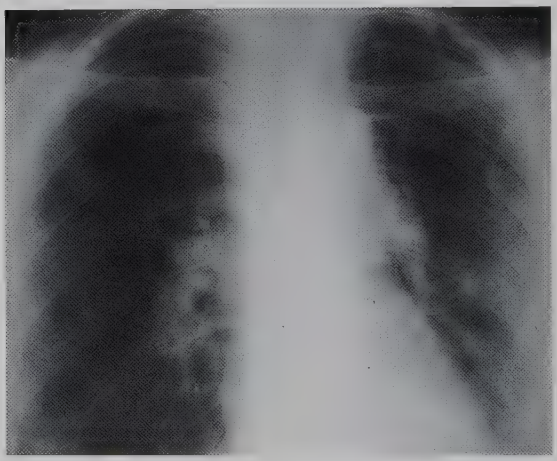

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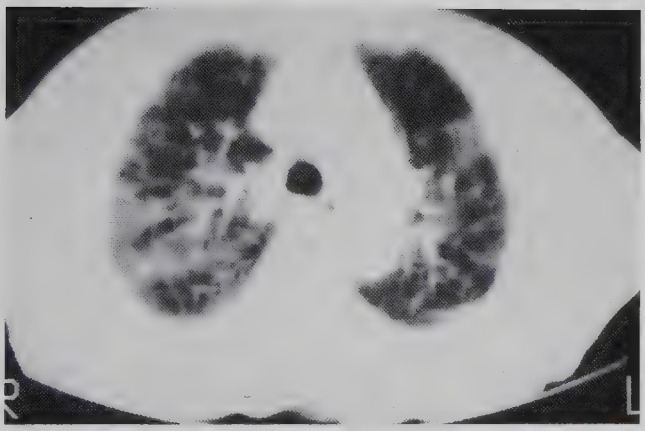
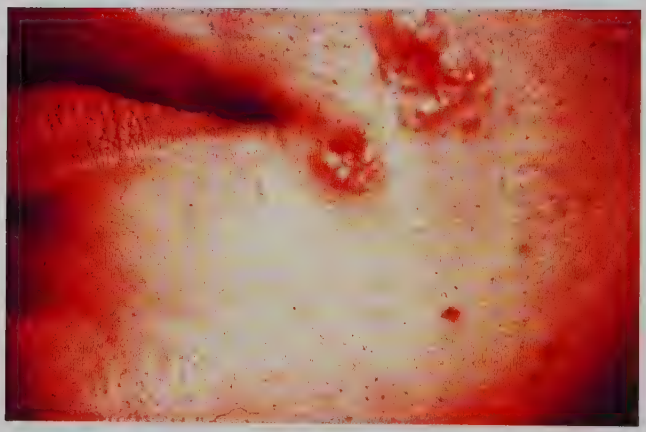



107

**107** ♦ Mycobacterial disease with multiple cavities and fibrotic changes are shown on chest computed tomography.



108

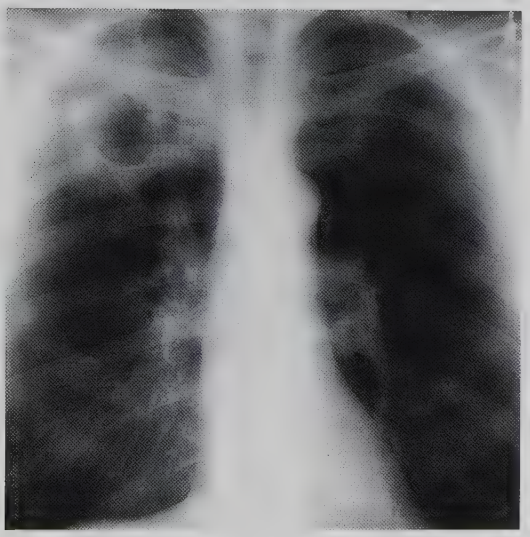
**108 ♦** *Mycobacterium tuberculosis* cutaneous infection. Although most infections are by the aerosolized mode, infection by skin inoculation is possible.

109

**109 ♦** Autopsy specimen of *Mycobacterium avium* complex (*M avium* and *M intracellulare*) showing apical cavitary disease. This is the most common organism responsible for nontuberculous infection capable of pulmonary radiographic findings similar to *Mycobacterium tuberculosis* in patients without acquired immunodeficiency syndrome and disseminated disease.

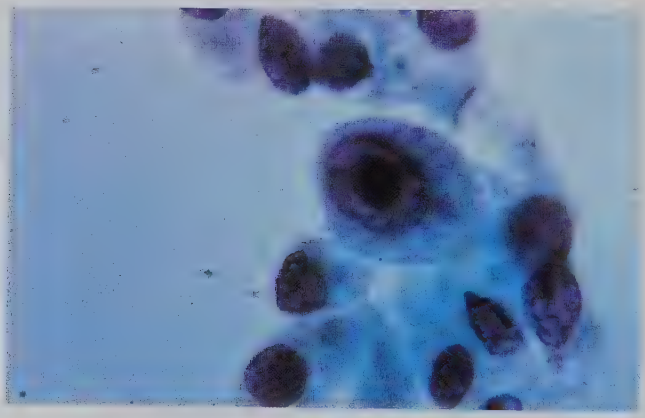
110

**110 ♦** Cutaneous lesions of *Mycobacterium avium intracellulare,* resembling sporotrichosis. The common atypical mycobacteria that produce skin lesions similar in appearance to sporotrichosis include *Mycobacterium marinum, Mycobacterium kansasii, and Mycobacterium chelonei.*



111

**111 ♦** *Mycobacterium avium-intracellulare* infection. A right upper lobe cavitary lesion is shown.



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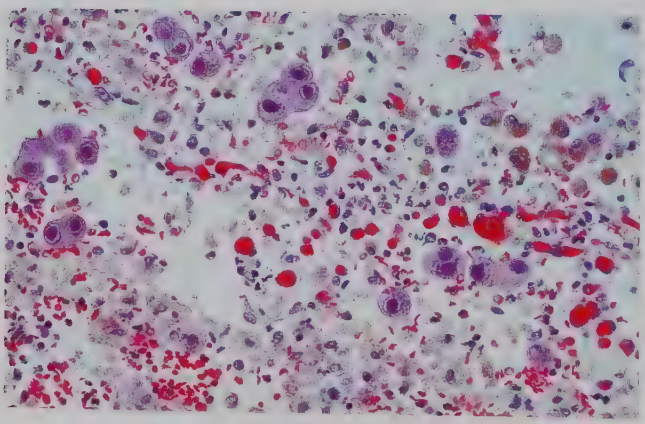

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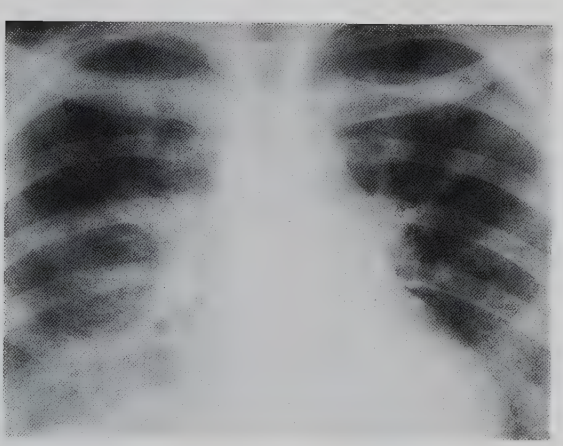
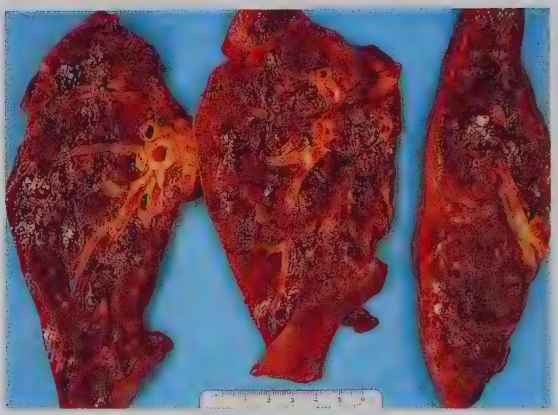


114

**112 ♦** Specimen from bronchoalveolar lavage showing an intracellular inclusion body. In the diagnosis of cytomegalovirus (CMV) pneumonitis, the cytologic appearance of CMV-infected cells from bronchoalveolar lavage classically shows a dense intranuclear inclusion body with a halo separating it from the thickened nuclear membrane.

**113 ♦** Characteristic cytomegaly with intranuclear and intracytoplasmic inclusions of cytomegalovirus.

**114 ♦** The typical radiographic appearance of cytomegalovirus pneumonitis is one of diffuse or focal interstitial pneumonitis. Rarely, it may present as a miliary infiltrate, focal area of segmental consolidation, or a discrete nodule.



115

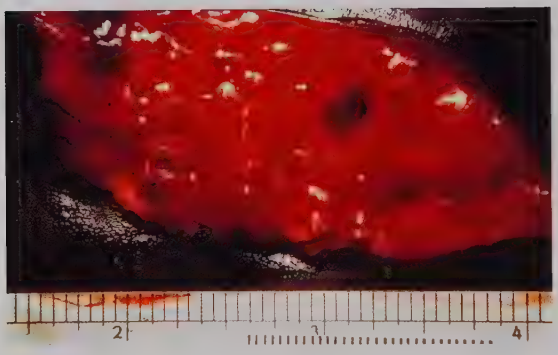
116

117

**115** ♦ Autopsy study depicting diffuse cytomegalovirus pneumonitis.

**116** ♦ Typical rash of measles. Discrete red macules and papules are present.

**117** ♦ Oral mucosal examination of Koplik spots. These oral mucosal lesions, described as 1- to 2-mm bluish-gray specks on an erythematous base, are pathognomonic for this illness. These characteristic lesions occur opposite the premolars and can be found as well on the palate, other areas of the buccal mucosa, and palpebral conjunctivae.

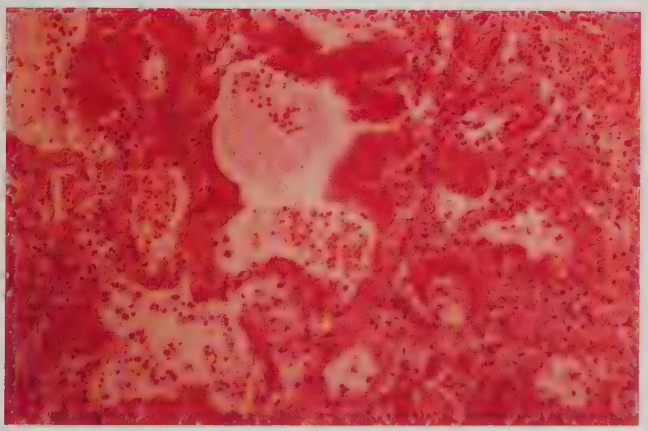


118

**118** ♦ Autopsy specimen of fulminant measles pneumonia depicting diffuse pulmonary parenchymal involvement.

**119** ♦ Diffuse alveolar disease (hemotoxylin-eosin stain). Although infrequent in presentation with measles infection, acute respiratory distress syndrome with diffuse edema and hemorrhage can occur.

**120** ♦ Measles pneumonitis showing a characteristic multinucleated giant cell (hemotoxylin-eosin stain). Intracytoplasmic and intranuclear inclusions have been identified within the giant cells in measles pneumonitis. These have also been found in parainfluenza and respiratory syncytial virus infection.



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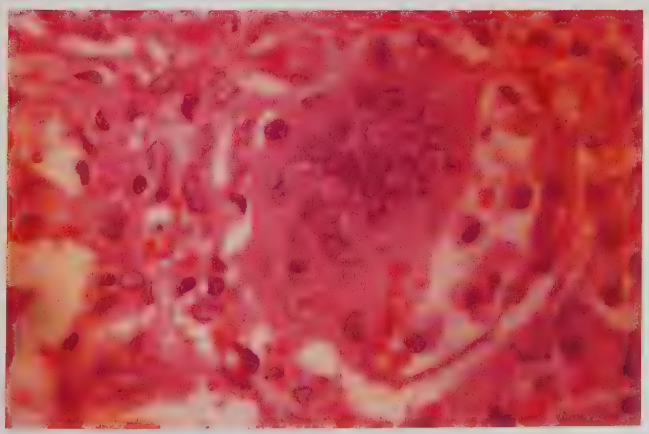
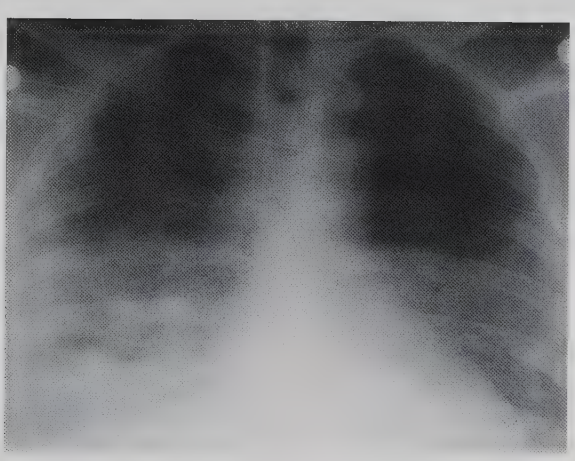


120

121

**121 ♦** Characteristic vesicular rash of primary herpes varicellae infection: chickenpox.



122

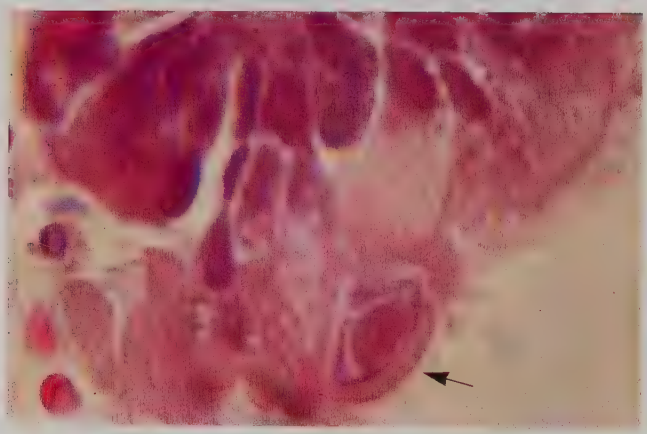
**122 ♦** Acute varicella pneumonia. Anterior-posterior view shows bilateral airspace consolidation primarily involving the lower lung fields. Patchy, diffuse airspace consolidation is the characteristic finding on the chest radiograph in acute varicella pneumonia. The pattern of diffuse, multiple, small calcified nodules is an uncommon finding, but may represent a remote history of varicella pneumonia.

123

**123 ♦** Kaposi's sarcoma. The facial cutaneous lesions are frequent, macular-to-papular in presentation, with a red-to-purplish hue.

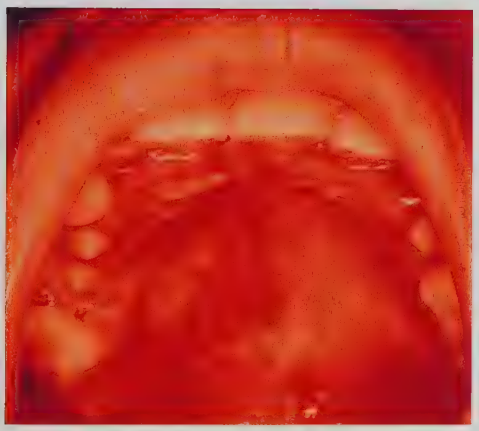
124

**124 ♦** Lung parenchymal changes in Kaposi's sarcoma. A common radiographic presentation includes multiple parenchymal nodules with pleural involvement, manifested by pleural effusions. In persons infected with the human immunodeficiency virus, Kaposi's sarcoma—a multisystem neoplasm—is part of the broad differential diagnoses of clinical syndromes of dyspnea and pulmonary infiltrates.



125

**125** ♦ Tracheal airway epithelium showing multiple nuclei in the airway epithelial cell (see arrow). This finding can be seen with herpes simplex viral infection.



126

**126 ♦** Severe herpes stomatitis characterized by painful vesicles on an erythematous base that is prone to ulceration.

## *Clinical Pearls*

**1** ♦ Cytopathic change of lung cells can support the diagnosis of viral pneumonia. Colonization of the airway can occur with cytomegalovirus (CMV) without overt infection. Other techniques for identifying CMV infection include viral culture, monoclonal antibody staining, and in situ hybridization techniques. Cytomegalovirus can colonize the airways without evidence of overt pneumonitis, creating diagnostic difficulties.

**2** ♦ The classic appearance of *Mycobacterium tuberculosis* on chest radiograph is biapical cavitary lesions; however, it can affect the lung in other areas. In the primary infection of adolescents and adults, any pulmonary infiltrate may represent *M tuberculosis*. Lower lobe disease can occur in older patients, in patients with human immunodeficiency virus, and those with endobronchial tuberculosis with distal airway obstruction. Pleural infection occurs early after primary infection, with chronic pulmonary infection, and is associated with miliary (disseminated) infection.

**3** ♦ In the presence of a febrile illness and maculopapular rash, the identification of Koplik spots supports the diagnosis of measles.

## *Suggested Readings*


1. Barbee R. Coccidioidomycosis: no longer a regional problem. *J Respir Dis.* 1983;4:78-88.
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